inhalation therapy

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IN THIS ISSUE

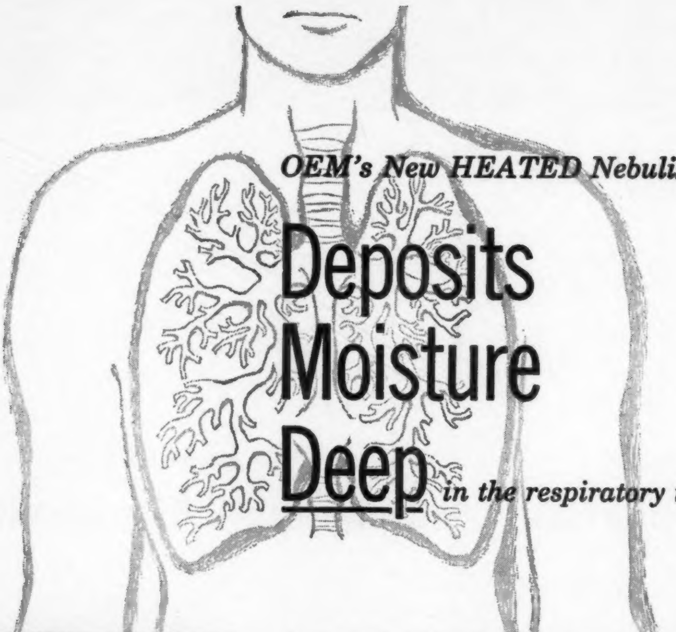
Part I of a three-part series on

Pulmonary Emphysema

A review of mechanical

Respiratory Aids

JOURNAL OF THE AMERICAN ASSOCIATION OF INHALATION THERAPISTS



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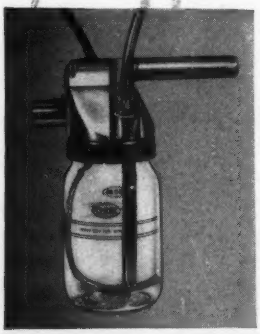

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******An Aerosol Method of Producing Bronchial Secretions in Human Subjects; a Clinical Technique for the Detection of Lung Cancer,* **Hylan A. Bickerman, MD, FCCP: Edith E. Sproul, MD, and Alvan L. Barach, MD, FCCP. Paper read before 23rd annual meeting of American College of Chest Physicians in New York City, June 15, 1957.**

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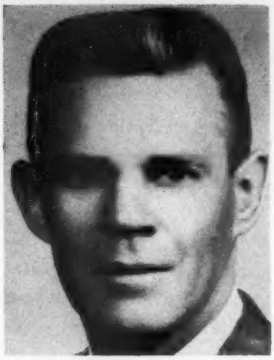

Editorial

Some Issues Clarified

AS THE AMERICAN Association of Inhalation Therapists starts its sixth year, and the American Registry of Inhalation Therapists comes into being, it is well to examine the position of the inhalation therapist to see how he fits into the scheme of this paramedical specialty, and, conversely, what these things have to offer him.

First of all, membership in AAIT—what does it offer? The AAIT is an organization of all those interested in inhalation therapy: Doctors, technicians, nurses, manufacturers of gases and equipment, purveyors of equipment, and suppliers of gases. All of them have a common interest—the eventual care of the patient.

Inhalation therapy is a paramedical specialty. It is not a *medical* specialty, because diagnosis and prescription are not its responsibilities. It does, however, furnish a medical service when requested. The physician who evaluates and treats patients is backed up by many consultants and technicians, all of whom supply services which he may or may not desire. It is the doctor's responsibility in his practice of medicine to order these services or not, as he sees fit.

There are a number of technical societies to which physicians do not usually belong. The AAIT is one of these. It does receive guidance from doctors, but within its own structure it is autonomous as an association. There must necessarily be a variety of specialized activities among its members. There is extensive interdependency. The AAIT offers a forum for these men and women, who may have divergent specific duties, but always a common goal: To help patients, to make progress, and to learn. Obviously, membership in such a group is a privilege—not a right. It is an opportunity for professional development not available elsewhere.

Because there is a wide spectrum of activity, it is necessary to identify people according to their principal activity. Hence, the categories of membership. These are *not* discriminatory—they are *identifying*. There are specific rules of eligibility for each. The *Members* are principally concerned with continuous, immediate, in-hospital care of patients. The *Industrial Members* are chiefly involved with the manufacture of gases and/or equipment. The *Service Members* are primarily engaged in purveying equipment—bringing it to hospitals and patients and setting it up. Thus members are identified. A person is no less a therapist because he is known by his principal responsibility. In fact, each category interested in the *entire process* of providing patients with good inhalation therapy should be proud to be accepted within the framework of a paramedical society.

It must be realized, however, that the *policies* of a society engaged in the care of patients must ultimately be determined by Medicine. This is so of medical specialty societies, the nursing associations, the hospital associations, or the various associations of technicians and therapists. The physician must decide what products, services, techniques and equipment will best serve his patient's needs. In his professional conduct

with patients, he is governed by a Code of Ethics. Such codes are for the protection of patients, but are established by physicians, so they are really self-disciplining.

Physicians *must* stand between their patients and commercialism or exploitation. They cannot endorse a product or a society if there is a conflict of interest. If there is, on the one hand, the prime interest in the care of the patient, and, on the other, the prime interest of being engaged in a venture for profit—even though it serves the patient—then there is conflict of interest. The first interest has responsibility to the patient; the second, to profit and to a corporation. A corporation cannot practice medicine—only physicians are licensed—and corporations are *not* bound by a professional code of ethics.

Applied to the AAIT, it is evident that the privilege to decide on policy must reside in those who are responsible to a hospital administration directly, and who receive their compensation from the hospital directly. This is so because the hospital is responsible to its Medical Board, and this in turn is governed by physicians and medical staff.

Two important problems face every organization in medicine and the allied specialties, both scientific and professional. These are education and certification. Education is a function of an association. When the diverse members have a sameness of purpose, a knowledge of the common goal and of the methods of attainment, then each person comprehends his role and performs this in an enlightened fashion. The integration of knowledge—the dissemination of information—is accomplished by meetings, at which there is interchange among all.

Certification, on the other hand, is a function of an examining body—a Board or a Registry. Whatever its name, its function is to determine competence and skill. Actually, it determines whether an individual possesses the minimum amount of skill or ability deemed necessary to perform his duties, and in respect to medical and paramedical disciplines, whether the individual is a *safe* physician or a *safe* therapist. He must not be one who endangers the life of a patient, either through lack of skill or lack of conscience or character.

That last statement sets the two goals of the examining body: First, to assess the moral character and type of person who is to assist in the care of the sick; and second, to estimate his abilities, knowledge and skill. *Basic* qualifications call for proper age, standard education which would equip the individual to meet everyday problems likely to be encountered in his work, possession of attributes of etiquette, and a good moral character, as evidenced by membership in a reputable professional organization, and by lack of a criminal record.

Special qualifications are: An adequate period of training, either in a recognized school or under a preceptorship type of schooling; an adequate period of experience; a written examination to reveal the degree of general knowledge of the subject; and an oral examination to determine the degree of his practical knowledge and skill.

When all these requirements are successfully met, the candidate's name is posted in the list of qualified therapists (the Registry), and a certificate of registration is issued to him or to her. Not everybody will be able to meet all the requirements nor pass all the examinations. It is not expected that everyone interested in inhalation therapy will be certified, but it is a challenge to strive for better skill and to improve one's abilities. Thus there will be improved patient care. Standards must always be high when people's lives are at stake.

—Vincent J. Collins, M.D.

The length of this monograph requires that we divide the condensation into three parts. Part I, here, describes the ailment; Part II, to be published in April, will discuss testing, CO_2 narcosis and respiratory acidosis. Part III, in June, will describe treatment. (Condensed from CIBA CLINICAL SYMPOSIA, *Volume 10, Number 6, and reprinted with permission of that publication and the authors, Drs. Farber and Wilson).*

Pulmonary Emphysema: Part I

More frequent than TB or lung cancer, emphysema is the most common chronic disease of the lungs

by Seymour M. Farber, M.D. and Roger H. L. Wilson, M.D.

EMPHYSEMA IS by far the most common chronic disease of the lungs. More frequent than tuberculosis, more frequent than lung cancer, it is the major single cause of disability having pulmonary origin.

Emphysema may be defined as enlargement of the whole, or a part of the, lung due to loss of inherent elasticity. The alveoli themselves have very little elastic tissue. The main elastic system of the lungs is therefore contained in the bronchi, bronchioles, alveolar ducts, and blood vessels. Thus the problem of emphysema is primarily a pre-alveolar problem. The alveolar stretching and rupture are secondary developments, contributing further to the disability.

Dr. Farber, left, is assistant dean, University of California Medical Center (Continuing Education), chief of the University of California tuberculosis and chest service at San Francisco General Hospital, and president of the American College of Chest Physicians. **Dr. Wilson** is assistant clinical professor of medicine, University of California School of Medicine in San Francisco, and is in charge of the pulmonary physiology laboratory on the University of California Service, Ward 62, San Francisco General Hospital, San Francisco, California.

Localized Emphysema. Only an isolated area of a lung may be involved. This may follow infection, a developmental defect, or a localized bronchial obstruction from a tumor or foreign body. Under any of these conditions, the bronchus may be so occluded that air passes only at the peak of inspiration. When expiration begins, the bronchus closes completely, acting like the check valve on an automobile tire. The air can pass in one direction only—into the alveoli, but not out. This produces single or multiple *bullae*, or rounded tension cysts. Alveolar rupture into subpleural space may produce a *bleb*. Recognition of the presence of a bleb is important, because it presents the threat of spontaneous pneumothorax.

A simple atrophic condition, *senile emphysema,* causes chronic shortness of breath. On the other hand, shortness of breath may be found in *compensatory emphysema,* where a portion of the lung expands to make up the thoracic volume after a pneumonectomy or a lobectomy, or in pulmonary atelectasis or fibrosis. Senile emphysema and compensatory emphysema are not in themselves seriously disabling diseases, except where the obstructive element develops due to loss of elasticity. Therefore, we shall confine our discussion to chronic generalized obstructive emphysema.

Chronic Generalized Obstructive Emphysema. This is a condition in which expiration is chronically embarrassed. Chronic bronchial allergy and/or chronic infection is commonly present. Recoil of alveoli is impeded and elasticity destroyed with consequent enlargement, coalescence, and loss of alveolar function. The picture is that of chronic wheezing dyspnea, leading to respiratory failure with embarrassment or failure of the right side of the heart.

The normal lung has an immense amount of functional reserve. Hence, many patients do not complain of any breathlessness until half or even two-thirds of this reserve is lost.

Etiology. The two most frequent precursors of emphysema are *allergic asthma* and *chronic infectious bronchitis.* If persistent, both of these conditions will inevitably lead to varying degrees of emphysema.

Once emphysema has been produced, a recurrent vicious circle results. The bronchi and bronchioles in the emphysematous area tend to trap and retain allergens and/or bacteria. Retained mucus is an excellent culture medium; therefore, the mere presence of emphysema tends to encourage exacerbations. These lead to further tissue destruction and degeneration.

In some cases *intrinsic tissue weakness* may be involved. We believe that even without pathologic insult certain people will tend to develop degenerative changes in small bronchi before others. We accept individual differences of tissue susceptibility to degeneration in the heart and great vessels, or in the skin where some people develop earlier wrinkling, and in other tissues. Thus it seems only reasonable to believe that the same sort of individual difference in susceptibility to degeneration may exist in the bronchi.

Clinical Course. One of the earliest symptoms of emphysema is wheezing on effort. It is important to understand the meaning of a wheeze. This may be demonstrated by blowing through a reed. No sound is produced until the sides of the reed are compressed. So it is with the bronchi: When the lumen is narrowed either by spasm or loss of elasticity, a wheeze is produced. Therefore one must remember that "All that wheezes is *not* asthma." What is even more important, considering the laws of probability, is: "When one hears a wheeze, the *first* diagnosis to consider is emphysema."

As the disease progresses and more lung tissue becomes involved, the symptoms become more severe and are brought on by less and less exertion. In addition, it is subject to exacerbations whenever the patient gets a respiratory infection.

The final stage is the development of cor pulmonale with pulmonary artery hypertension and right heart failure, and of respiratory acidosis. Death of most of these patients is due to respiratory acidosis in the presence of heart failure.

Pathogenesis. The sequence of events leading to the full-blown pathologic picture of obstructive emphysema is relatively clear. A series of mechanisms causing bronchial narrowing can be defined.

Bronchial narrowing is *not* synonymous with *bronchospasm.* Often this latter word is used with unfortunate looseness to describe all sorts of wheezing. However, spasm can refer only to the bronchial musculature. This is smooth muscle, having a slow, rhythmic peristalsis and a normally partially contracted state. Any allergic or infectious process in a bronchus will produce reflex nerve activity that can increase the degree of smooth muscle contraction and narrow the bronchial lumen.

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Far more important than the bronchial musculature are the changes that take place in the *mucosa* and within the *bronchial lumen*. These are illustrated in Plates I and III.

Allergy or infection produces edema and cellular infiltration of the mucosa as well as an increase in secretion of mucus. With the narrowing produced by changes in the mucosa and submucosa, cough becomes less efficient. This leads to retention of excessive mucus. When dyspnea develops, mouth breathing further thickens the mucus, making it still more difficult to dislodge, and additionally compromising the area of the bronchial lumen.

The retention of mucus encourages the continued growth of bacteria. Leukocyte migration into the inspissated mucus is minimal. Thus, although the mucus may contain a considerable number of organisms, the leukocyte migration necessary to deal with these organisms does not occur.

With increasing difficulty in expiration, a more and more inflated position of the lung is adopted. Thus the patient develops an increase in the antero-posterior chest diameter, with flattened depressed diaphragms. As the lung continues to enlarge, it is functionally less efficient. Also, the pulmonary blood supply may be compromised. Cough becomes markedly less efficient, and dyspnea increases, further tending to increase the disability.

Pathology. The loss of elasticity of the lungs in generalized emphysema is far from uniform. The various changes in gross appearance are illustrated in Plate I. The changes in intra-thoracic pressure on inspiration and expiration, both in the normal and in the emphysematous patient, are shown in the manometers (see also Plate III).

It will be seen that in the emphysematous patient the chest cage is enlarged both on expiration and inspiration. The diaphragm is flattened and does not rise as high on expiration.

In the normal, the alveolar pattern is rather uniformly sponge-like. However, in the emphysematous lung, many different changes are apparent. Even when emphysema is generalized, some alveoli or even some lobules may be entirely normal. Others may have partially lost their elasticity. Still others will be found functionally completely and irrevocably destroyed.

In Plate I a large cyst is shown in the upper lobe, which changes in size very little between inspiration and expiration. The elasticity having been almost completely lost and a papillary outgrowth in the bronchus acting like a check valve, this area is functionless, and by occupying space in the chest cavity, it actually impairs the function of more normal areas.

Below this will be seen a cyst that retains some elasticity, being somewhat reduced in size on expiration. This cyst retains some ventilating function, but its capacity for gaseous exchange is greatly decreased because of impairment of its blood supply and the breakdown of alveolar walls.

Around this cyst is an area of atelectasis. This latter region is white because the lymphatics have washed all the carbon away—evidence that the contained alveoli have been functionless for a very long time. This atelectatic area probably contains the very best alveoli in the lungs, having excellent elastic tissue. However, other areas of the lung, with little or no elasticity, have prevented the development of a sufficient amount of negative pressure to expand any normally elastic alveoli. Thus, in spite of the fact that this area would be capable of good function in a normal lung, placed as it is in an emphysematous lung, the relatively normal alveoli are completely functionless.

Below, and medial to this region, the lung is fairly normal. However, even here some areas are semi-atelectatic.

The non-ventilating, functionless cyst at the apex is served by a large bronchus, which has become fragmented, rupturing into an alveolus. This alveolus in turn has ruptured into other alveoli so that the entire cyst is composed of broken alveoli. In the bronchus subserving the large cyst A, the muscle and mucosal layers are

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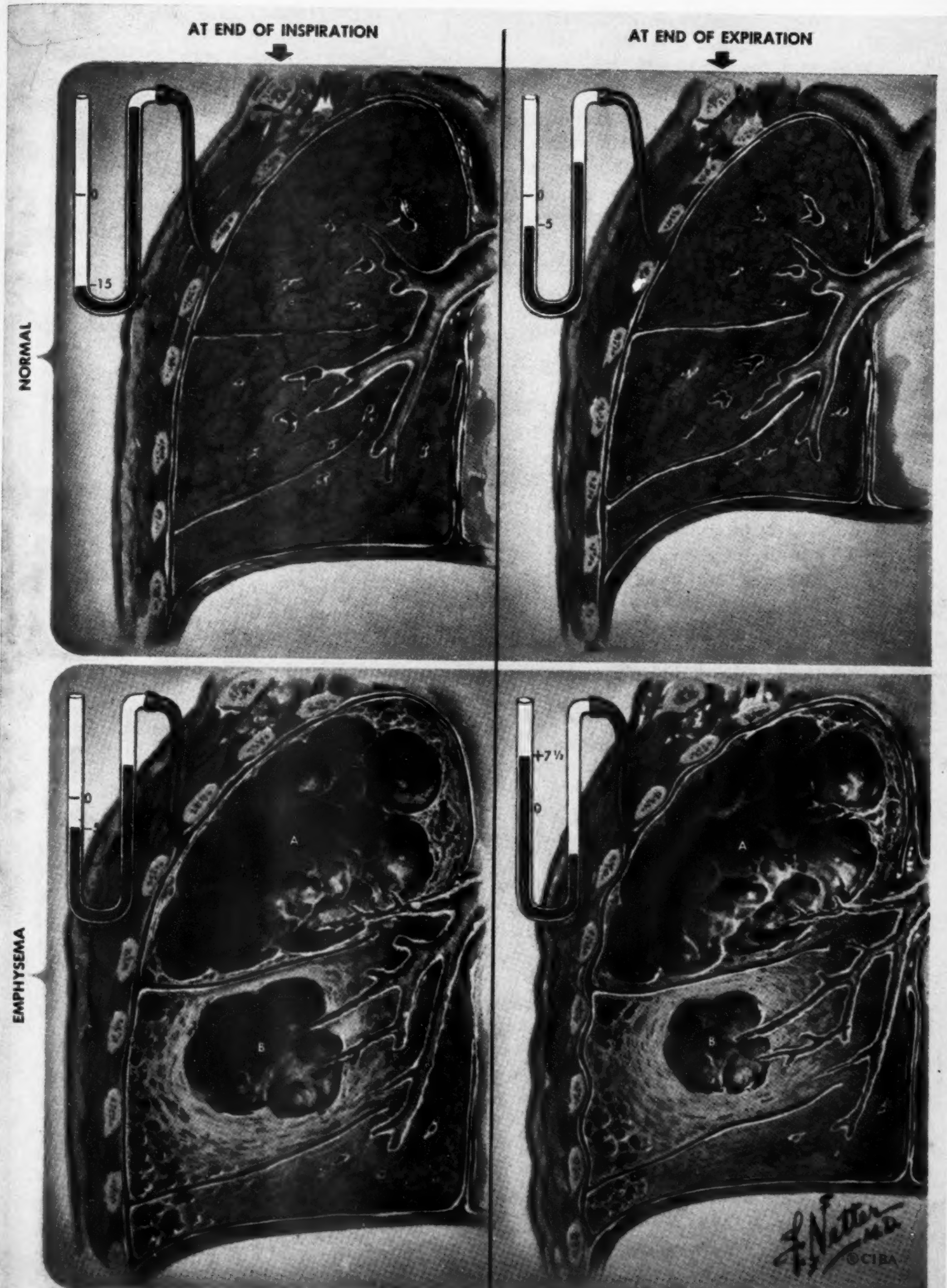

PLATE I—GROSS PATHOLOGIC CHANGES IN EMPHYSEMA

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somewhat hypertrophied. The lumen contains a papillary outgrowth which may have caused obstruction. The submucosa is thickened by edema and infiltration. There is also a plug of mucus containing some incompletely detached cells in alveolus A, which must act as a block even to inspiration.

Cyst B has some elasticity and a fairly large opening. Therefore it ventilates; however, it is relatively useless from a functional point of view.

Pulmonary Blood Vessels (Plate II). *A functionless area of the lung will lose its blood supply because a minimum oxygen tension in the capillary blood is necessary if perfusion by way of the pulmonary arteriole is to continue.*

Thus the large non-ventilating cyst A previously shown in Plate I has almost completely lost its blood supply. In the partially functioning cyst B, only a small blood supply remains. This cyst also is practically useless for gaseous exchange.

Below this the alveolus C in the atelectatic area has also lost its blood supply. Although this is one of the least affected alveoli in the lung, it has become functionless. The lung having become voluminous, the normal elasticity of this alveolus has caused it to contract, so that it no longer is being used for ventilation. Deprived of oxygen, vessels have constricted and finally disappeared, and circulation of blood has ceased.

Alveolus D represents a damaged broncho-alveolar unit that is the main functional unit remaining. Having impaired elasticity, it has enlarged. Definite bronchial changes are present. However, a sufficient degree of elasticity remains for it to function in ventilation, and therefore its blood supply is rather well preserved.

Pneumodynamics (Plate III). In the illustrations on page 18 the suspended balloons represent the lungs, the weighted plungers represent the muscles of respiration, and the cylinder represents the thoracic cage. In the normal, the elasticity of the balloon opposed by muscle contraction and muscle tone combines to maintain a negative pressure during expiration as well as during inspiration.

In contrast, the balloon in emphysema has lost its elasticity. It is, therefore, larger both on inspiration and expiration, as is the total content of the cylinder. Also, due to loss of elasticity the excursion of the cylinder is much reduced in emphysema. In addition, during expiration pressure must be exerted upward in the piston to force air from the flaccid balloon.

This pressure may constrict or even completely obstruct the neck of the balloon, so that it is difficult or impossible to expel air from it, regardless of the degree of pressure exerted.

The lung diagrams in Plate III schematically depict the bronchial changes that contribute to loss of elasticity in impairing ventilation. These factors include thickening of the mucosa and submucosa by edema and cellular infiltration, collection of mucus which tends to become dessicated, development of polypoid growths, and bronchospasm.

The manometers indicate the intrapleural pressure on inspiration and expiration in both normal and emphysematous subjects. In the normal there is a negative intrapleural pressure even on expiration, due to the elasticity of the lung. On inspiration this negative pressure is increased to about 15 mm of mercury.

In the emphysematous chest, where elasticity is greatly reduced, there is very little negative pressure even on inspiration. On expiration the pressure may become positive, reaching 7.5 mm of mercury or more above atmospheric pressure. In other words, whereas in the normal person expiration is a passive act, the air leaving the lungs because of elastic recoil, in emphysema the patient must literally *squeeze* the air from his chest, producing a positive intrapleural pressure.

To maintain an adequate bronchial lumen, air pressure on the inside must be greater than on the outside of the bronchial wall. The bronchi in the normal lung remain patent even in forced expiration, because the intrathoracic pressure on the outer walls of the bronchi is less than the atmospheric pressure within the lumen.

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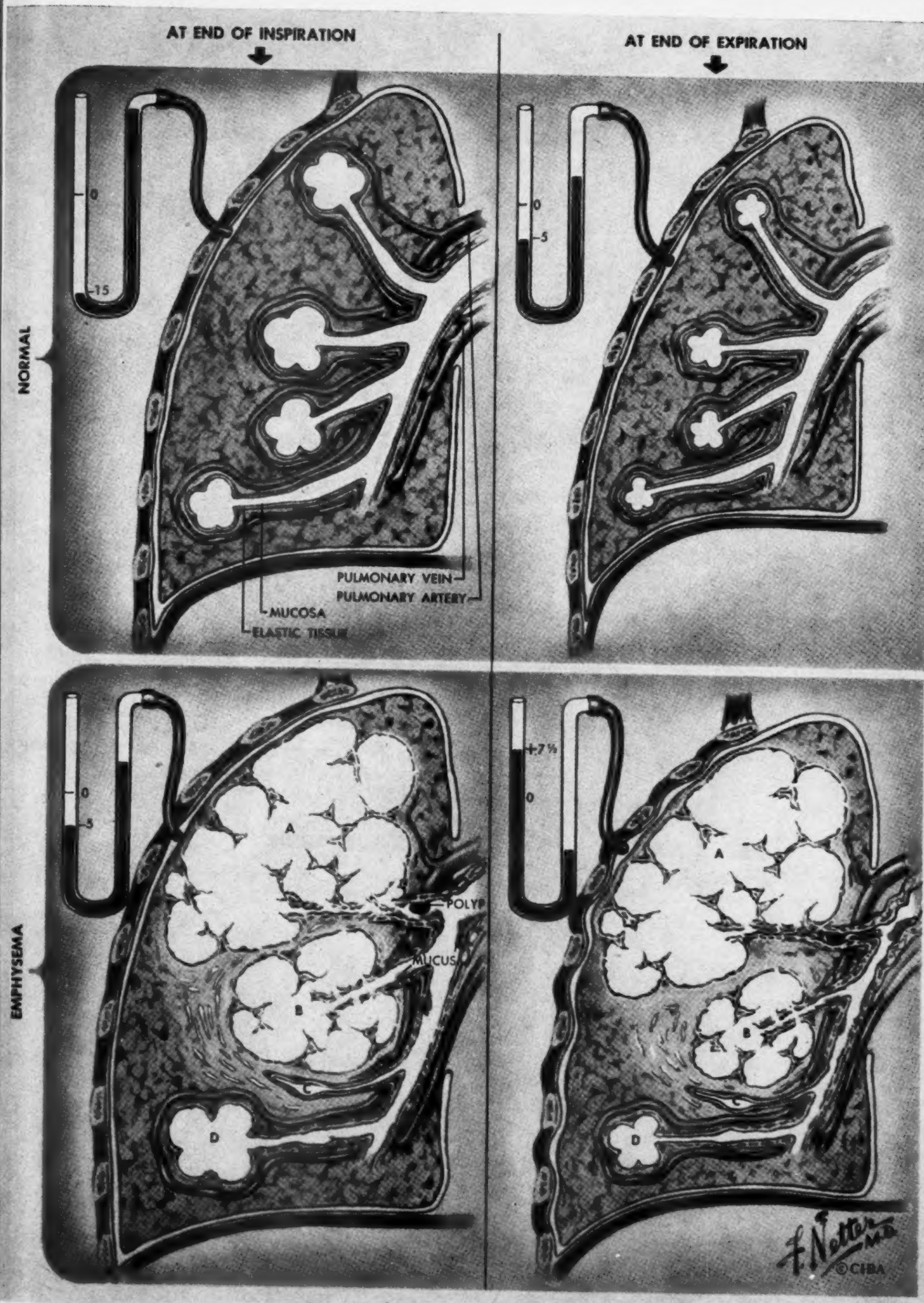

PLATE II—PULMONARY BLOOD VESSELS IN EMPHYSEMA

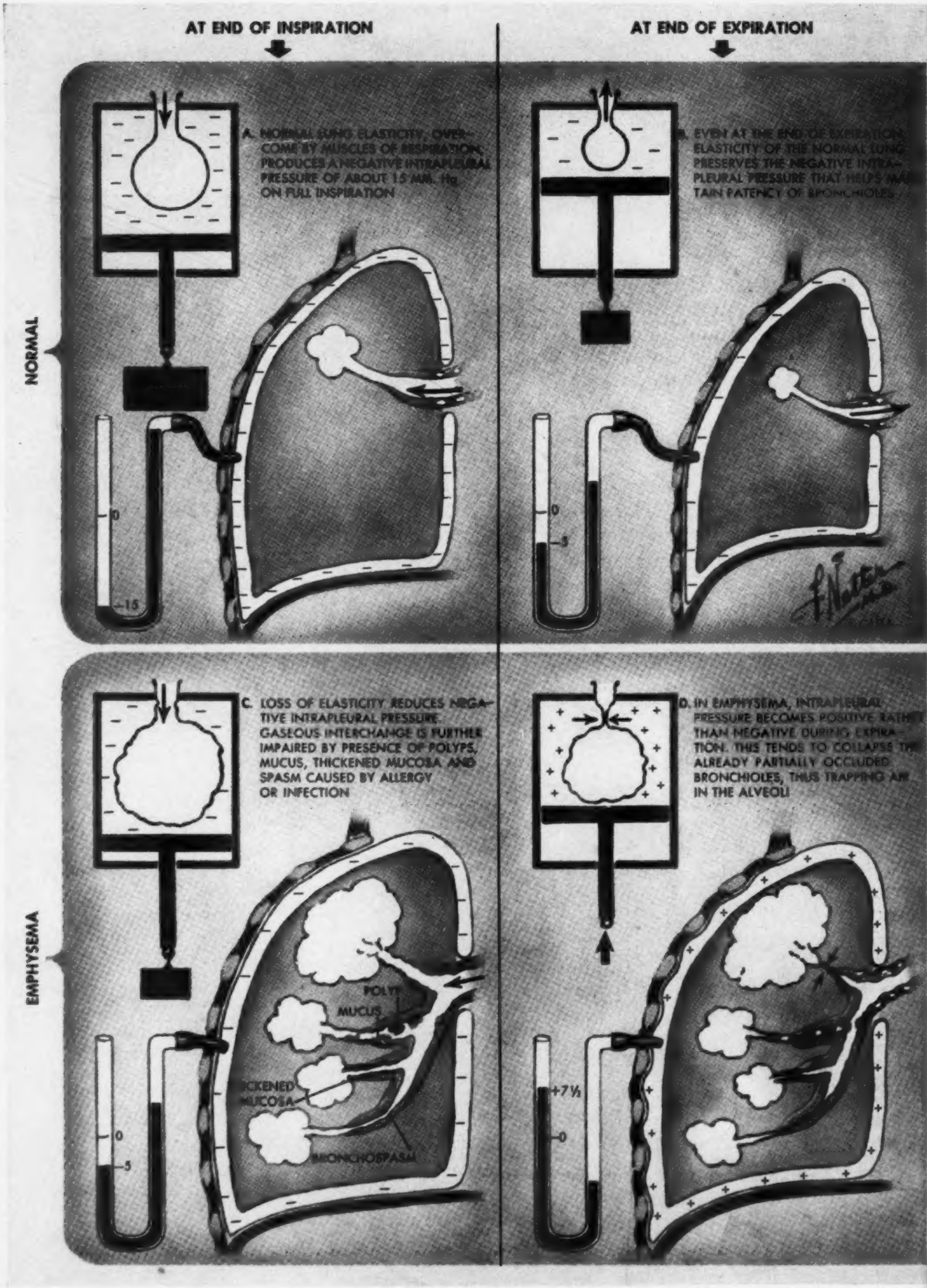

PLATE III—PNEUMODYNAMICS OF EMPHYSEMA

Therapists must become more expert as use of respiratory aids grows

by William C. Allen

THE GROWTH OF inhalation therapy as a paramedical specialty makes it obvious that the trained therapist will be an "expert" in respiratory aid techniques and will likely, in no small number of instances, be "the expert."

Already in some localities, inhalation therapists are *the* technicians with the knowledge and the ability to make application of the various mechanical respirators. There is apparently no question that the use of all types of mechanical respiratory aids is increasing and as this use spreads, along with the whole field of inhalation therapy, it well behooves the inhalation therapist to have a working knowledge of all such equipment.

Tank Respirators. Most everyone is familiar with the iron lung or tank respirator. The iron lung is generally considered to provide the most efficient form of artificial respiration so far as the mechanics of breathing are concerned. However, it is a large, bulky piece of equipment, hard to move, and leaves something to be desired in the convenience of patient care. The iron lung is an air-tight enclosure in which the patient is placed with his whole body – with the exception of the head – enclosed, and with a sealing collar around the neck. Pressures within the tank are varied by a diaphragm or bellows-type pump. When a sub-atmospheric pressure is created within the tank, this causes the thoracic cage to expand, accompanied by lung expansion which causes the patient to inhale. Usually the pressure in the tank is then reduced to atmospheric pressure and normal elastic forces cause exhalation. Positive pressures inside the tank can be provided to squeeze the thoracic cage and thus aid exhalation. Pressures used are adjustable through mechanical valving devices and rate of respiration is adjustable through variable speed drives to the pumping unit. Hand hole ports with sealing devices and transparent viewing ports are provided in the tank to make it possible for limited nursing care to take place while the tank is breathing the patient. Plastic domes are also provided for enclosing the patient's head in an air-tight enclosure while the patient is slid out of the tank for care. For this operation the

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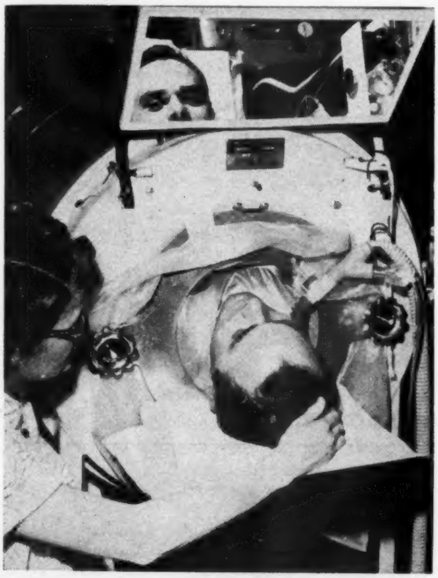
patient is breathed by positive pressure to the dome.

Self-contained 120-volt generating units or battery-operated inverter units providing 120 volts can be used to operate the tanks, making it possible to move them from one place to another without being attached to a wall outlet. Light-weight, battery-operated, portable pump units also can be used to operate the tanks in lieu of their regular pumping units to provide movability.



The iron lung—generally considered to provide the most efficient form of artificial respiration—does have its drawbacks. It is large, bulky, hard to move, and somewhat inconvenient for the best patient care.

Light-weight half tanks with stretcher handles, using a separate portable pumping unit, also have been used to provide a fairly high degree of portability for a patient in a tank. These half tanks have become much more usable with the introduction of truly light-weight, dependable, portable pumping units which operate from automobile batteries.

Chest Type Respirators. A newer, smaller, and more convenient type of respirator is the chest shell respirator. This consists of a chest shell, or cuirass, which is strapped to the patient covering his chest or chest and part of his abdomen. There is a space between the shell and the body which is sealed around the outside with a sponge rubber or air-filled sealing device. A separate pumping unit attached to the shell through a flexible hose varies the pressures inside the shell with relation to atmospheric pressure in a rhythmic manner similar to the way pressures are varied in a tank. In the same way that a tank works when the pressure in the shell is reduced below atmospheric pressure, it causes expansion of the chest wall and thereby inspiration. Change then to atmospheric pressure or above atmospheric pressure inside the shell permits the thoracic cavity to contract or helps it to contract and cause expiration. Pressures used, as well as rate of respiration, are adjustable in the pumping unit. The cuirass respirator can be used by a patient who is in a regular hospital bed and also in most cases by a patient who is sitting up in a wheel chair or in an automobile. The advantages over the tank respirator in convenience are obvious.

When chest shells were first used the pumping units were fairly large and bulky and although some of them were called "portable" because they would operate from a battery power source, they still did not provide much greater ease for moving the patient about than did the tank. However, in the last three or four years, cuirass pumping units which are truly portable have been developed. These machines are light in weight and are small enough in size so that they can be mounted together with the battery for operation directly under a wheel chair (even a child's wheel chair). They can be easily carried and used in an automobile and they operate from either 120-volt house current or 12-volt battery. Chest shell, or cuirass, pumping units may be reciprocating units using the piston, or bellows-type pump, or rotary units using the air turbine, which is the type of pump you are accustomed to in a vacuum cleaner. The smallest and lightest weight units all use the turbine.

Battery Operation. For several years light-weight plastic battery cells have

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been used to operate portable respirators because the cells are non-spillable, light in weight, and have small colored balls whose position indicates the state of charge. Lately, however, more and more regular automobile batteries are being used to operate these machines because they are much cheaper in price and because they give longer operating times. Then too, since most automobiles today have 12-volt electrical systems, it is proving most convenient to operate the respirators from 12-volt sources.

24- to 32-volt airplane battery systems when used in conjunction with a proper voltage regulator. A 12-volt machine on a long-life automobile battery will run just as long as any of the machines operating on 24-volt batteries.

Positive Pressure Respirators. The pumping units used for operation of the cuirass also all can be used with the proper attachments for positive pressure breathing. They provide a machine-controlled intermittent flow of room air, pressure and rate adjustable. They can be used for

The cuirass respirator, which covers the chest and part of the abdomen, can be used by a patient who is in a regular hospital bed and, in most cases, by a patient sitting in a wheel chair or an automobile. Small, light-weight, truly portable pumping units have been developed to use with the chest respirator.

Some of these portable respirator pumps operate from 24-volt rather than 12-volt battery systems in order to provide longer battery operating times. They, of course, will not operate from a 12-volt automobile battery system, although they will operate from most airplane battery systems. The 12-volt battery units also operate from the

breathing a patient through the mouth by means of a mouthpiece or through the nose and/or mouth by use of a mask, or through a tracheostomy tube. *Efficient humidification of the air stream must be provided when breathing a patient through a tracheostomy because such*

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breathing by-passes the normal humidification of the upper respiratory system.

Pumping units of a similar nature utilizing the air turbine but still smaller in size and lighter in weight have been developed for use in positive pressure breathing only. These units can be used for positive pressure through mouthpiece or face mask and also through tracheostomy tube. As in the cuirass-type respirators, these machines control the rate and depth of respiration, both of which are adjustable to the requirements of the individual patient. These machines are useful for breathing those patients who are unable to breathe by themselves or who find it difficult to ventilate satisfactorily by themselves but who are able to cooperate to the extent of relaxing so the machine can do the breathing for them.

There are patients who have sufficient breathing power of their own and are uncooperative to the extent that they fight this type of apparatus and for them it may be difficult or impossible to use. It is for such patients as this that the patient-cycled demand valve type of positive pressure breathing apparatus with which most inhalation therapists are already completely familiar is most useful. Several of the patient-demand type valves which operate from a high pressure compressed air or oxygen source also have automatic cycling devices incorporated. With these valves you can adjust both pressure and rate of respiration and breathe a patient with positive pressure in much the same manner as you would breathe him with one of the turbine type respirators.

A further development of the turbine-type positive pressure device is represented by those machines that provide a continuous flow of air with adjustable pressure and flow rate and which must be cycled either by the user or an attendant. Techniques of smoking like a pipe, and tongue or finger cycling, are used. The patient using this type device can completely control both the rate and depth of his respiration. Because of their simplicity these devices can be made much smaller and lighter in weight than any of the others previously described. They also are made to operate on either 120-volt house current or 12-volt battery. They are used principally as therapeutic devices for positive pressure therapy, deep breathing, or lung stretching exercises, and cough assistance. However, in some areas, this same type of apparatus is used for positive pressure breathing, patient controlled, over fairly long periods of time, i.e., for several hours.

A development stemming from this last described apparatus is a combination of the continuous air turbine with a second pump of the diaphragm-type making provision for the use of aerosolized medication along with the positive pressure. Through this device IPPB is provided, being made intermittent either by the patient or an attendant. Where intermittent positive pressure therapy using room air is desired this type of apparatus provides a highly convenient and portable as well as economical arrangement. Some of the patient-demand type valves also are provided with pumping units providing room air in order to make their operation more economical and in some cases somewhat more convenient.

Abdominal Belt Respirator. Probably the newest form of mechanical respiratory assistance is provided by the inflatable abdominal belt. Although the crude forerunner of this device was successfully used in England 25 years ago, it is only in the last two or three years that it has been used to any extent in this country. This device consists of a corset-like belt which is strapped around the abdomen of the patient extending a little over the lower ribs. Inside the front of this belt covering the abdomen is a balloon-like inflatable bladder. A separate pumping unit similar to those described above is used to alternately inflate the bladder and permit it to exhaust. When the bladder is inflated the abdominal contents are squeezed inward resulting in an elevation of the diaphragm causing exhalation to take place. When the air exhausts from

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the bladder, the abdominal organs sag down allowing the diaphragm to drop, thus assisting inhalation. This device depends to a varying extent on the forces of gravity acting on the abdominal contents to pull the diaphragm back down, so that very few patients have received adequate ventilation from it in a prone position. Some pumps, of the piston type, provided for the abdominal belt respirator operate from both 120-volt house current and 24-volt battery and can be used for positive pressure breathing and for pumping the smaller sizes of chest shell as well as for

The abdominal belt respirator powered by portable batteries means greater mobility for the patient.

pumping the belt. Considerably smaller and lighter pumps, of the turbine type, operating from 120-volt house current and 12-volt battery are available for pumping the belt and also for positive pressure breathing.

Rocking Bed. The rocking bed, although dissimilar in operation from the apparatus described above, also is a mechanical respiratory device and should be included here. The rocking bed rocks back and forth like a see-saw and the rate of rocking, as well as the extent of the excursion from horizontal at the foot and at the head, is adjustable. When the feet of the patient are down, the abdominal contents pull the diaphragm down and cause inspiration. When the head is down and feet are up, the abdominal contents falling in the other direction push the diaphragm upwards in the thorax and cause expiration. Many people are quite satisfactorily ventilated as they sleep on the rocking bed.

Undoubtedly development of mechanical respirators and respiratory assisters will continue and the progressive inhalation therapists not only will want to become familiar with those now available, but keep abreast of future developments.

AAIT CHAPTERS

The American Association of Inhalation Therapists now has 21 chapters, the most in its history. Here they are with their headquarters city:

CHAPTER	CITY
Bay County (Michigan)	Bay City
Boston	Boston
Connecticut	New Haven
Delaware Valley	Wilmington
Florida	Miami
Greater Montreal	Montreal
Greater New York	New York City
Illinois	Chicago
Michigan	Ann Arbor
North Texas	Dallas
Ohio	Cleveland
Rocky Mountain	Denver
Southeast Texas	Port Arthur
Southern California	Covina
Southern Ontario	Toronto
South Texas	Houston
Tennessee	Nashville
Upper Midwest	Minneapolis
Western New York	Buffalo
Washington, D.C.	Washington
Wisconsin	Milwaukee

Additional chapters are being formed.

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In the emphysematous lung, on the other hand, the lungs have lost much of this negative pressure along with their elasticity, and bronchi tend to collapse. During inspiration in emphysema the bronchioles contain air at atmospheric pressure (760 mm Hg.). On the outside of the bronchi there is a negative pressure (perhaps 755 mm Hg.). This pressure difference of 5 mm Hg. is sufficient to keep the bronchioles expanded.

However, on expiration this differential is reversed, the intrathoracic pressure going from negative to positive. This causes the relatively flaccid bronchioles partially to collapse.

When dyspnea is present, this bronchiolar collapse is intensified. The patient who is literally fighting for breath, trying his best to force air through flattened bronchioles, merely succeeds in flattening them further as he increases the positive pressure in his chest by muscular effort. Indeed, with enough effort he can even succeed in squeezing some of the bronchioles completely flat.

THE AAIT OBJECTIVES

The American Association of Inhalation Therapists is an international organization of therapy technicians working: In hospitals, for firms providing emergency oxygen therapy service, and for municipal organizations. The Association's objectives:

1. To encourage and develop educational programs for people interested in the field of inhalation therapy;
2. To advance the science and art of inhalation therapy through institutes, meetings, lectures, and publications (including this Journal);
3. To aid the advancement of the technical aspects of inhalation therapy; and
4. To facilitate cooperation between inhalation therapists and the medical profession, hospitals and other agencies interested in inhalation therapy.

The AAIT is jointly sponsored by the American College of Chest Physicians and the American Society of Anesthesiologists. Three doctors from each group comprise the joint Board of Advisors to the AAIT.

CHAPTER ACTIVITIES

by Jack Sangster

THE **SOUTHERN California Chapter** presented a program on "Inhalation Therapy in Respiratory Deficiencies" in the Life Science Building, U.C.L.A. Medical Center, Los Angeles, California, in December. The program chairman was Walter L. Jones, senior inhalation therapist at the U.C.L.A. Medical Center, and chapter president.

Highlights were two films; the first, "A Clinic on Recognition and Management of Respiratory Acidosis," prepared by Reginald H. Smart, M.D., Hurley L. Motley, M.D. and Joseph F. Boyle, M.D., all of Los Angeles. Dr. Motley, who is professor of medicine and director of the cardio-respiratory laboratory at U.C.L.A. Medical Center, gave a lecture based on the film.

The second movie was "Rescue Breathing," prepared by James O. Elam, M.D., David Green, M.D. and Max Schneider, M.D., at Roswell Park Memorial Institute, Buffalo, New York. It was discussed by Verne L. Brechner, M.D., assistant professor of surgery/anesthesiology at U.C. L.A. Medical Center.

The **South Texas Chapter** held a workshop at Saint Joseph's Hospital in Houston in September. Particularly emphasized in the addresses were techniques and hazards, precautions and regulations. Seventy persons representing 11 hospitals in Houston, Galveston and Brenham, attended.

Kudos are especially due the Southern California and South Texas chapters, for successfully bringing off these educational meetings in their areas at such tender ages; each of these chapters was only a few months old at the time!

The **Upper Midwest Chapter** held its semi-annual meeting at St. Mary's Hospital in Duluth, Minnesota, in December, as part of a two-day institute presented jointly by the chapter and the Duluth hospitals at St. Luke's and St. Mary's hospitals.

The 13 speakers included physicians, nurses and administrative personnel from Chicago; Duluth, Brainerd, and Rochester, Minnesota; and Rice Lake, Wisconsin. Topics ranged over the whole field of inhalation therapy, and were variously presented as lectures, panel discussions, symposia, an equipment clinic and four films: "Safe and Effective Oxygen Therapy," "The Breath of Life," "Oxygen Dosage and Technique," and "Mouth to Mouth Resuscitation."

The December meeting of the **Greater New York Chapter** was held at the Mount Sinai Hospital, New York City, and featured the talk on "Inhalation Therapy Equipment — Its Maintenance and Storage," by Joseph J. Klocek, R.N., which he gave at the annual meeting of the AAIT in Philadelphia last November.

"Resuscitation and Resuscitators" was the topic presented to the **Western New York Chapter** at its December meeting by Robert M. Lawrence, M.D., one of the chapter's advisors. The talk was supplemented with lantern slides and demonstrations of representative equipment.

At its annual election in December, the **Florida Society of Inhalation Therapists** chose these officers: Bruce Boyd, Jackson Memorial Hospital, president; Idilio Borges, Veterans Administration Hospital, first vice president; Russell Yeager, Mercy Hospital, second vice president; Vic Aruanno, Jackson Memorial Hospital, secretary; Robert Stott, Variety Hospital, treasurer; and Melvin Hall, Variety Hospital, sergeant at arms. Mr. Hall is the outgoing president. During December, the chapter voted to hold two meetings a month during 1960 for intensive study and the holding of seminars in preparation for examinations under the national registry (see pages 10-11). Topics will include physiology, pharmacology, anatomy, chemical and physical properties, etc.

EDITOR'S CORNER

Upwards into Orbit

THOSE WHO read our articles last March and September regarding respiratory considerations in space flight will be interested in following the experiments being conducted at Brooks Air Force Base, Texas.

Lt. Col. George R. Steinkamp, chief of the department of astro-ecology for the Air Force's School of Aviation Medicine, recently revealed plans for confining two volunteers in a space cabin simulator for 30 days.

The simulator, a seven-ton device eight feet high and twelve feet long has been built by the Minneapolis-Honeywell Company's Aeronautical Division plant in Minneapolis, and is the first of its kind in the free world in which men can live for as long as a month in complete isolation from the world, closely approximating conditions imposed by space travel.

The volunteers will breathe and re-breathe the same air and drink and re-drink the same water, as a result of automatically controlled purifying systems in the space capsule. There also are pressure, temperature and humidity controls, nonperishable foods and even recorded music.

Information from the space capsule is piped outside to a highly instrumented console which will precisely record environmental conditions and occupant reaction for study by space medical researchers.

Despite the physical problems of living in cramped quarters for an extended period, the greatest stresses are expected to be psychological.

"The men who enter the cabin will be completely sealed off from the world to which they have become accustomed. The familiar day-night cycle they live by will be lost," Col. Steinkamp said. "Time will weigh heavily on their minds, and boredom will become their constant companion. Thirty days can be a very long time."

Winter Games' Medical Care

Therapists who ski will be interested in the elaborate medical plans for the VIII Olympic Winter Games at Squaw Valley, California, February 18-28.

A squad of 10 skiing physicians will be only a minute's schuss from any competitor injured on the slopes of Squaw Valley during the Games. William W. Stiles, M.D., professor of public health at the University of California, heads the medical division of the organizing committee.

A 28-bed emergency hospital, a pharmacy, five medical aid stations in Squaw Valley, four more outside the valley at points where personnel will be housed, a central supply station, three training or physio-therapy rooms, a mobile and evacuation section with a fleet of six four-wheel drive military ambulances, two over-snow vehicles, eight station wagons as well as sleds for transporting patients over snow, and officers for administrative and public health personnel comprise the impressive array of facilities.

Four months before the games, more than 200 people were mobilized for staffing these facilities, including a pool of 80 physicians, 60 nurses, a dentist, ambulance drivers, X-ray technicians, lab technicians, physio-therapists and public health and sanitation experts. All of these persons are contributing their time and labor gratis. Fortunately, they will all have such quantities of clean, pure fresh air that no inhalation therapists have been enlisted!

Those Meeting Notices

Now that the Journal will be coming out every other month, and since you usually lay plans for institutes a few months in advance, your editor would appreciate notice of coming meetings in time for inclusion in the Journal which comes out *before* the event. This would give you *advance* publicity, and people in nearby areas might be able to attend.

When sending notices, please include exact dates and locations, registration fees, and the full name and address of someone to whom readers may address inquiries. If there is to be an emphasis on any particular aspect of inhalation therapy, this also should be mentioned. Remember, copy must be received for the Journal *not less than 60 days prior to the first of the month of publication* (February, April, June, August, October or December).

BOOK REVIEWS

RESPIRATORY PHYSIOLOGY AND ITS CLINICAL APPLICATION, by John H. Knowles, M.D., *Harvard University Press,* 1959.

Dr. Knowles' preface starts off with the remark that this book "is intended for the medical student and practicing physician."

As he goes on to say: "There are many excellent sources available concerning *normal* respiratory physiology, but as yet there is no single source where the interested physician *without previous experience* may turn to obtain information as to the methodology, indications for clinical use, limitations, and interpretations of pulmonary function tests" (italics mine). It is because he is aiming this treatise at relatively inexperienced physicians and medical students that there is very much in it which is readily digestible also by the interested therapist who will read these clear explanations.

It should be emphasized that this is not primarily a textbook on how to do pulmonary function tests, although some of the simpler, more useful determinations are described. But it is a book which in many ways throughout shows how valuable these tests are in establishing diagnoses and in assessing the effectiveness of treatment. Considerable space is devoted to the very important business of contrasting normal with abnormal respiratory physiology in the delineation of common pulmonary disorders confronting the clinician—and, of course, the therapist.

The first section of the book deals with the concepts of ventilation and gas exchange, the diffusion of gases, the distribution of inspired air in the lungs, and the relationship between the ventilation of the alveolus and the perfusion of the alveolus with blood. In connection with these chapters, he presents the simple function tests which are used to give information on these quantities, tells how to do them, what their limitations are, and how to interpret them.

There also are very straightforward discussions of the work of breathing, arterial blood studies and the blood's acid-base balance. In the latter, he distinguishes between respiratory and metabolic acidosis and alkalosis—terms which therapists are hearing more and more, and should understand.

The disordered physiology encountered in various pulmonary disease entities is treated in Part II. Here there are chapters on emphysema, asthma, heart disease, polio and other neuromuscular diseases affecting respiration, polycythemias, idiopathic alveolar hypoventilation, kyphoscoliosis, pulmonary air cysts, pneumonectomy, and on the upward displacement of the diaphragm caused alike by pregnancy, ascites and pneumoperitoneum.

In his conclusion, Dr. Knowles asserts that we are definitely behind ourselves in coming to routine pulmonary function testing as a diagnostic aid, citing the long-accepted use of the EKG and the whole batteries of function tests available for investigation of liver and renal disorders.

"It is now possible to diagnose three definite types of physiologic abnormality, each of which may be present in pure form, and each of which may result from a variety of disease processes," he says. "Once the physiologic parameters of pulmonary function have been established, one can evaluate and define the benefits of and therefore the needs for specific therapy such as antibiotics, bronchodilator drugs, positive pressure breathing, artificial respiration, steroid drugs, various thoracic surgical procedures, and oxygen administration."

The second section of the book is less than half the volume, as there are about 35 pages of references at the end—a very comprehensive bibliography useful to anyone who wants further information. —J.F.W.

TRACHEOTOMY: A Clinical and Experimental Study, by Thomas G. Nelson, M.D., Major, M.C., *The Williams & Wilkins Company,* Baltimore, Maryland, 1958.

Dr. Nelson divides his monograph—after its introductory historical outline — into two main sections: One presenting clinical material and the other treating research work.

The historical sketch itself is an entertaining chronicle running from the partly-hearsay accounts of early tracheotomy operations way before the birth of Christ to the better-documented development of the technique over the years to the present. Except for recent years, he gives credit for much of the modern concept about this procedure (1909-1945) to Dr. Chevalier Jackson.

The clinical material section develops indications for the operation, such as mechanical ventilatory obstruction and secretional ventilatory obstruction, with outlines of causes for each major type. There is a wealth of other interesting information on the operation itself, but what is of real importance to the therapist is the aftercare of the tracheostomy, and Dr. Nelson has definite guidance to offer here:

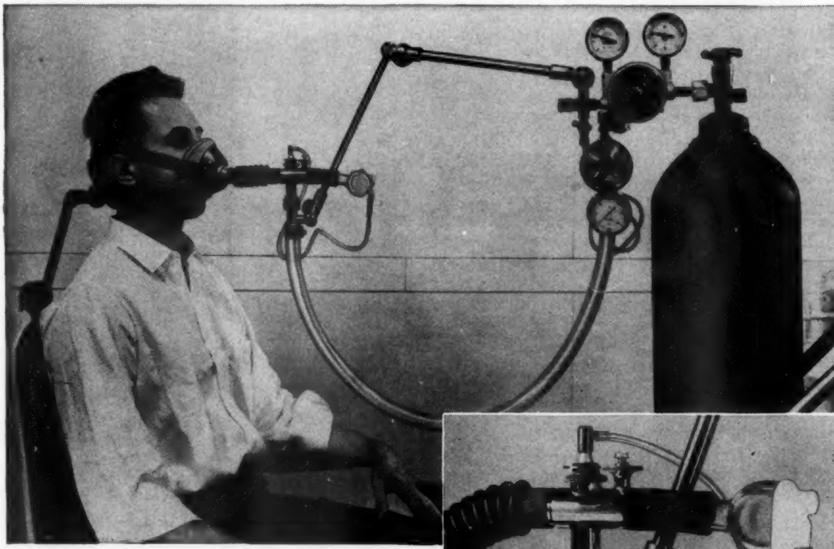
"Three basic steps in aftercare necessary to keep the airway clear: (1) Checking, cleaning and changing the cannula as often as needed; (2) Humidification of inspired air; and (3) Proper aspiration of tracheobronchial secretions."

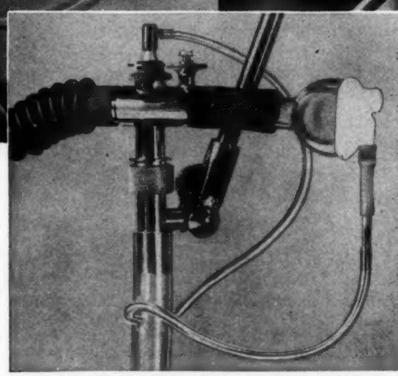
Blockage of the cannula may be caused by a mucus crust attached to the end of the cannula, and "crusting is best prevented by adequate hydration of the patient, careful humidification of inspired air, and avoidance of dry oxygen administered directly into the trachea, and constant removal of secretions so that these do not accumulate and become dried. The removal of crusts is facilitated by heavily saturated aerosol mist administered directly over the tracheotomy opening, by flushing with saline or saline-penicillin mixture, or by the use of detergents such as Alevaire."

It is easy to see the important role played by the inhalation therapist in this picture. It is re-

concluded on page 36

For the efficient and simplified administration of I.P.P.B.I. therapy... the improved M-S-A Pulmonary Ventilator... mobile or cylinder model





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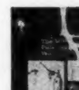


Every day—in many ways—MSA products safeguard millions of lives

concluded from page 34

iterated that a high percentage of deaths and complications following tracheotomy are directly traceable to faulty aftercare.

There are much-needed remarks regarding proper and improper aspiration techniques, and the point was made that "non-professional but well-trained assistants, under close supervision and after proper instruction, became quite adept at clearing the airway of secretions using the tracheotomy opening."

The experimental work studied types and locations for incision, and particularly the effects of these and other factors on the healing of the tracheotomy wound after decannulation.

"The study revealed that there is no difference in healing with any of the common methods of incising the trachea, and that stenosis or other deformity of the airway was due to prolonged use of the cannula and the formation of excessive granulation tissue about the tracheotomy opening."

It was concluded that more tracheotomies are being done because of increasing recognition of the value of this procedure in facilitating removal of secretions, decreasing dead space, and other physiologic advantages, "rather than for its classic use in bypassing a mechanical obstruction of the airway." In fact, Dr. Nelson says "tracheotomy has become well accepted in the management of nearly every type of ventilatory distress."

Since the inhalation therapist is (or should be) intimately involved in the aftercare of the tracheotomy patient, the practical information available here will be most valuable.

The book ends with an excellent long bibliography for the benefit of those who may wish further information. —J.F.W.

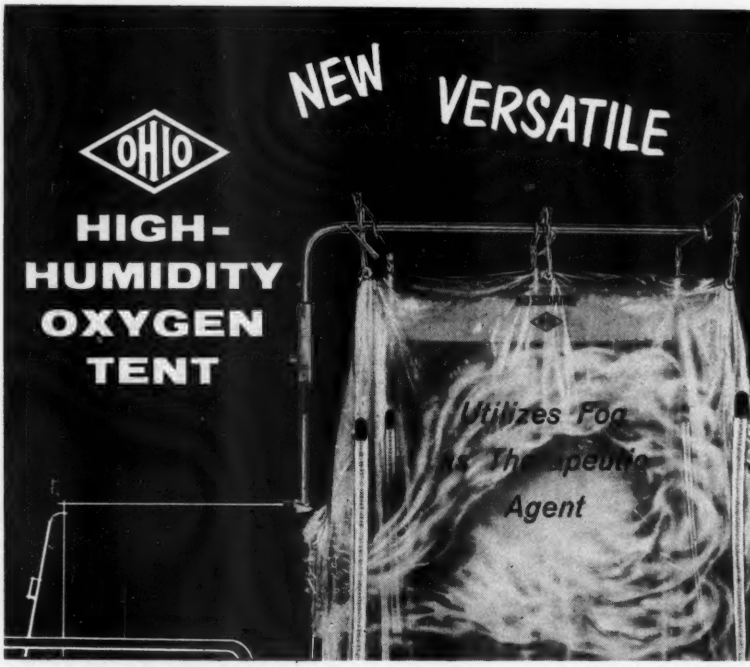
A GRAPHICAL ANALYSIS OF THE RESPIRATORY GAS EXCHANGE, by Hermann Rahn, Ph.D., and Wallace O. Fenn, Ph.D., *American Physiological Society*, Washington, D.C., 1955.

This ingeniously contrived set of nomogram charts with transparent overlays so carefully plots the inter-relationships between such parameters as pO_2, pCO_2, per cent saturation of hemoglobin, volumes per cent CO_2, pH, etc. that it is possible with only minimum information to read directly from the nomograms many values which would be hard to arrive at short of arterial puncture and time-consuming laboratory procedures, or laborious calculations.

The charts probably of most use to clinicians and therapists are the first two, which both concern man at sea level. pO_2 is plotted on the horizontal axes and pCO_2 on the vertical axes of the graphs. The first shows the relationship of volumes per cent CO_2 to volumes per cent of oxyhemoglobin in the blood. The second shows plasma pH and the per cent saturation of hemoglobin.

To use, the gas exchange ratios overlay sheet is simply placed over the appropriate chart.

—J.F.W.



One simple control lets operator cover humidity range from that obtained in standard tents to a saturated fog. Fog provides high therapeutic value with minimal external wetting of patient because moisture forms in stable particles that do not coalesce. Messy, uncomfortable "rain" is completely avoided. The fog generator has no moving parts, does not tax the compressor unit and may be easily removed for cleaning. A clear, pliable plastic tube at the lower front section of the tent facilitates filling and draining of the large-capacity reservoir and also provides a visible indication of the water level at all times. Can be used as standard oxygen tent by merely turning humidity control knob to "OFF" position.

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EQUIPMENT NEWS

(Information and photographs are supplied by the manufacturers or distributors)

Hudson Bubblers and Jets

The Hudson Oxygen Therapy Sales Company, Los Angeles, has brought out two oxygen humidifiers—a standard bubbler type, and a jet type.

Tougher than all brass for the purpose, these lightweight humidifier tops are molded of nylon with chrome brass inserts for thread reinforcement, and are autoclavable. Both units have positive safety relief valves and handy, finger-controlled wing nuts. They are available with either unbreakable polyethylene pint Mason jars with neck reinforcements or with standard glass jars.

The bubbler type humidifier is equipped with a removable metal diffuser head. The jet type, used for oxygen therapy purposes requiring humidity approaching that of the respiratory tract, has a twin jet nebulizer with an efficient baffle.

Both of these humidifiers are suitable for use with standard regulators or piping installations.

No. 511

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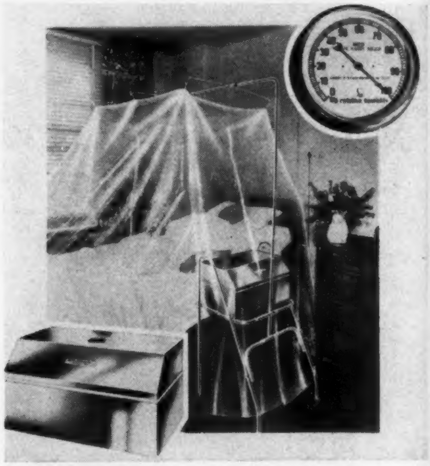
Continental Humidifier

Continental Hospital Industries, Inc., Lakewood, Ohio, is introducing a humidifier which is neither a steamer nor a nebulizer. This unit will produce a very high relative humidity in an enclosed space (either a crib or a hospital bed each with a canopy) within a few minutes, or will serve as a room humidifier.

The cabinet illustrated is of stainless steel and has a water reservoir of 16-hour capacity, to which ice may be added for cooling if desired.



A disposable type filter insures that air is cleaned as well as humidified. The unit features silent operation since it does not utilize an air compressor.

This device is called the Mark I Humidifier, and can be mounted on the tubular stand illustrated for use with a canopy. Also available with the Mark I is Continental's Humidistat, for controlling humidity, and the Humidiguide (upper corner of cut), whose 6" dial gives the per cent relative humidity at a glance even from across the room.

No. 512

Ripair Plastic Tape

Oxygen Equipment and Service Company, Chicago, is now marketing a 1" adhesive-backed Mylar plastic tape which they call Ripair. Available in 25-foot rolls, this strong, transparent tape makes invisible and permanent repairs.

Disposable canopies, so desirable because there is no need for sterilizing, tear more readily than heavier ones. Ripair offers a simple means of quickly, neatly and effectively making thin canopies last for the duration of the case. The tape also is useful for mending permanent or semi-permanent type canopies, plastic sheeting, instrument covers, documents, books and papers.

No. 513